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Current perspective of the renewable energy development in Malaysia

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ABSTRACT

It is estimated that oil reserves will not last very much longer; thus, a switch to alternative energy solutions is crucial. The Malaysian government has already prepared to face the situation decades before. Many policies have been implemented, as well as programmes and initiative. Now, Malaysia is waiting for the ultimate solutions, the Malaysian Fit-in Tariff (FiT), which is scheduled to be implemented second quarter of 2011. This paper presents the main sources of alternative renewable energy in Malaysia and its potential as well as the main reasons Malaysia is turning to alternative energy solutions; to fully utilize its renewable energy (RE) resources, fulfill the energy demand in the future and to reduce carbon emissions. This paper also discusses the steps taken by the government in preparation for FiT and overcoming the barriers in RE development.

Contents

1. Introduction

Without support from certain act, renewable energies (RE) will never be price-competitive. It is often labeled as expensive, mostly because conventional energy is heavily subsidized. In Malaysia, subsidization for fuel is larger than the subsidy for education [1]. Globally, it is estimated that more than US$200 million is spent in the subsidization of conventional energy. In many countries, the subsidized fuel and electricity cancel out the advantages of the low operating cost of Renewable Energy Technologies (RETs). This is one of the key barrier in Renewable Energy Technology efforts besides several other barriers, such as, monopolistic and oligopolistic energy markets, low motivation in financing RET, weak political supports, lack of technical and institutional capacity and financial means and lack of awareness of potential and benefits of RET.

Besides the barrier in the dissemination of RET, there are several other disadvantages associated with the RET. Solar technology, for example is often stereotyped as not technically feasible for electricity generation due to its high cost since photovoltaic technology started with USD1500/W and with only 2% efficiency [2]. Thus,

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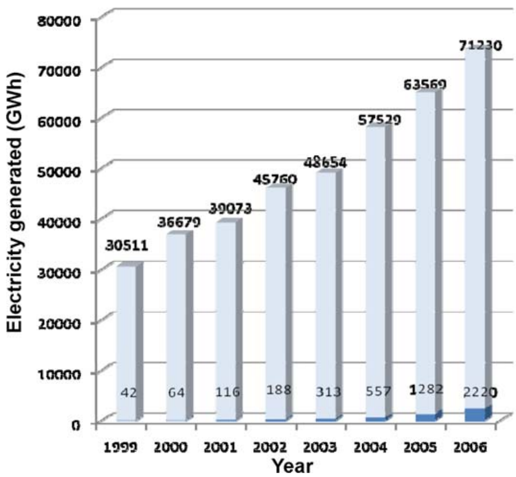

Fig. 1. Contribution of PV in electricity generation from renewable energies in Germany [8].

many were too dependent on fossil fuel, but until July 2008 when oil prices reached its highest at nearly USD150.00/barrel, people were forced to find alternative energy solution [3]. Currently, solar photovoltaic has reached efficiency of more than 40% and the cost is no longer expensive, but is as cheap as USD1/W for thin-film and is predicted to reduce even more [4]. Moreover, towards 2050, the cost of electricity generation from PV will be lower than coal and hydroelectric, while all renewable sources (except geothermal) will cost lower than USD0.12/kWh [5].

Now, renewable energy has been put in the limelight and researchers have increased their efforts in upgrading the efficiency of alternative power sources thus limiting the dependency on fossil fuels. Besides the cost factor, more and more people have realized that fossil fuels have a negative impact on the world's climate through the Greenhouse Gases (GHG) emissions. Among the most popular RE resources are; hydroelectric, wind, solar, biomass, geothermal and ocean energy and from these list, wind energy is the major producer. Although solar is available in every part of the world, it is still in the beginning for full utilization. Nonetheless, in some parts of the world, particularly in Europe and Japan, solar photovoltaic (PV) industry has become increasingly intense. RE could be generating electricity around the world and meet the global demand if a major shift in energy policy is made, such as that in Germany and Japan [6]. Particularly in Germany, the Renewable Energy Sources Act (EEG) implemented has demonstrated the effectiveness of joint industrial and political commitment through its most dominant and effective instruments, the fixed Feed-in Tariff (FiT). As evidence, since the act has been in force in April 2000, Germany has already achieved its target to generate 12.5% electricity from RE by 2010 in 2007, to a figure above 13%. In PV alone, contribution for electricity generation in the beginning year has showed an increase of more than 5% – more than the 1999 value – to 64 GWh. The following year, the value almost doubled to 116 GWh and the trend continued until 2006 with total generated electricity from PV of 2.2 kWh. Fig. 1 shows the contribution of electricity generated from renewable energies in Germany since FiT was implemented [7].

Meanwhile, the European Union (EU) countries had also introduced electricity FiT based on Germany's example and have gained success. In the Asia region, on the other hand, new enthusiasts such as China and India have indicated new and promising beginnings. China, for example, has steadily increased support for the Renewable Energy Research and Development since the 1990s. Moreover, in 2006, China had planned to increase the share of electricity generation from renewables to 30% by 2020. Significantly, the country

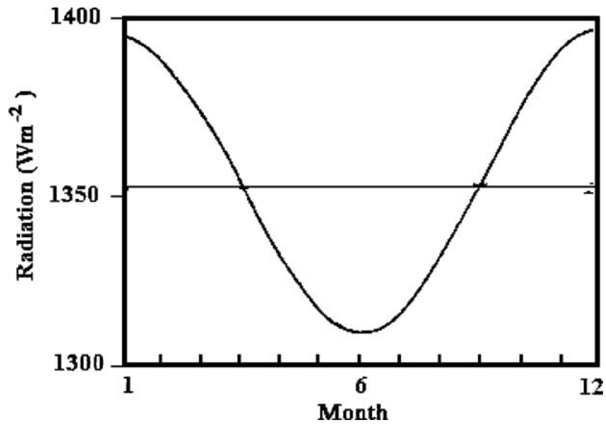

Fig. 2. Yearly variations of the solar constant [11].

has introduced a regulation based on the Renewable Energy Sources Act (EEG)-model in Germany to promote renewable energy in 2006 and has announced to raise more than 50 billion Euros for the expansion of renewables. India, in the meanwhile, has initiated a separate ministry to promote RE through various programmes, government incentives and policies including remunerative feed-in tariffs [8]. Nowadays, almost in every part of the world, renewable energy initiatives are taking place, and to be effective, a number of key political actions are required; put into practice the best support schemes, remove several barriers related and enforce legal enforceable mechanisms such as feed-in tariffs [9].

2. Renewable energies availability and potential in Malaysia

2.1. Solar

Solar energy represents an abundant resource, which theoretically could supply the world's energy demand. Currently, the Sun radiates energy at 3.9×10^{26} W, but energy received at the outer atmosphere of Earth is 1368 W/m^{-2}. This value varies in $\pm1.7\%$ due to changes in the Earth–Sun distance as in Fig. 2 [10,11]. The maximum radiation is received during a sunny day, where 90% of the extraterrestrial radiation become direct radiation while the rest are being deflected as diffuse radiation, while conversely, on a cloudy day, nearly all of the solar radiation is diffused as demonstrated in Fig. 3 [12]. A tropical country such as Malaysia is generally hot all year around and experiences its rainy season during the end of the year. With an average of 12 h of sunshine daily, the average solar energy received is between 1400 and 1900 kWh/m^2 annually. When using the solar dish for instance, there are some parameters that can be considered for maximizing the solar fraction [13]. Although Malaysia has high potential in solar electricity generation, the present initiatives and efforts are lower than the country's actual potential. Currently, the solar status in Malaysia is 1 MW, and its estimated potential can reach more than 6500 MW [14].

2.2. Biomass and biogas

In 2006, Malaysia was the second largest oil palm producer in the world, with a total of 15.88 million tonnes, an amount less 1% from the total world's supply behind Indonesia. Since the oil palm industry is huge, with 67% of agricultural land covered with oil palm tree, biomass from oil palm contributes the most. Currently, 85.5% of biomass residues come from oil palm industry, as shown in Fig. 4. Sources of biomass varies from empty fruit bunches, fibers, shells, palm trunks which each contains different levels of energy and the potential amount as demonstrated in Table 1. Oil palm has a very good potential in producing alternative energy due to its calorific

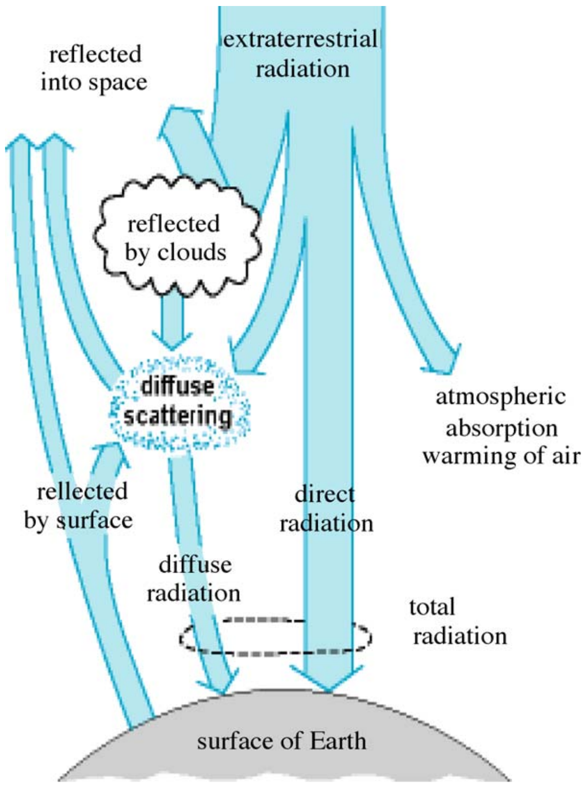

Fig. 3. Component of irradiation [12].

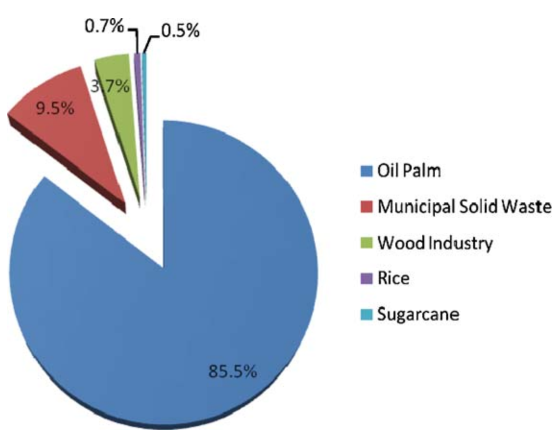

Fig. 4. Biomass contributions from various industries in Malaysia [14].

contains. With 50% efficiency, biomass from oil palm can generate 8 Mtoe of energy, and can save RM 7.5 billion per year of crude oil. In 2007, for each hectare of 4.3 million hectares of oil palm plantations, about 50–70 tonnes of biomass residues are generated. Besides oil palm, other agricultural waste such as bagasse, sugarcane, rice husks and wood waste residues also contribute to the total biomass residues [15–17]. As of July 2009, a total of 39 MW is under construction and it is estimated potential is 1340 MW by 2030 [14].

2.3. Mini-Hydro

With a total 330,000 km^2 of land area, Malaysia is covered with 42% of highlands area, namely some, Titiwangsa, Tahan, Kapuas Hulu, Crocker and Brassey. Blessed with abundant streams and rivers flowing from highland areas, Malaysia has numerous sites of hydro power potential. Currently, Malaysia has utilized these potential in the range of large and mini hydropower. In 2009, there are 12 large-scale hydropower stations and 50 mini scale hydropower stations available. In total, Malaysia has hydropower electricity generating capacity of about 18,500 MW in Malaysia. In July 2009, a total of 30.3 MW of mini-hydro is under construction and the expected potential by 2020 is 490 MW. Besides mini-hydro, micro hydro with a capacity ranges from 5 kW to 100 kW also has a good potential in electricity generation and not yet fully utilized in Malaysia [14,18].

2.4. Biogas and municipal solid waste

In Malaysia, biogas is commonly produced under anaerobic conditions using waste management facilities. Main sources include municipal landfills, Palm Oil Mill Effluent (POME) anaerobic ponds, industrial anaerobic ponds and agricultural anaerobic ponds. The energy content of biogas is mainly dependant on the methane content. Based on a study on the Clean Development Mechanism (CDM) potential in the waste sectors, it was found that the most potential is where anaerobic degradation takes place within the municipal landfills and POME ponds. The potential sizes of recovery and its relative power and heat potential for feasible projects are presented below in Table 2. In July 2009, a total of 4.45 MW is under construction and potential of biogas by 2028 is 410 MW [14,19].

Composition of solid waste in Malaysia can be divided into several groups: commercial, domestic, industrial, construction and municipal. Among these, domestic solid waste contributes the most, comprising almost half of the total waste. The average of MSW generated per person per day is 0.5–0.8 kg, but in major cities the value increases to around 1 kg per person per day. Mostly, the landfill method is being employed for disposing waste material, but in major cities, incineration is taking place. As the population increases, Malaysia will experience a growing production of MSW, thus creating bigger environmental problems to Malaysia. Based on a research, MSW from Kuala Lumpur alone contains 57% of organic content, thus the potential value of energy generation is higher. The calorific value of Malaysian MSW ranges from 1500 to 2600 kcal/kg and the energy potential from an incineration plant operating based on 1500 tonnes of MSW/day with an average calorific value of 2200 kcal/kg is 640 kW/day. In 2009, approximately, 21,000 tonnes of solid waste is produced daily. It is projected, by 2020; the Municipal Solid Waste will reach more than 9 million tonnes per year [20–22]. In August 2009, the status of solid waste power generation is 5.5 MW and by 2022, the potential is 360 MW [14] (Fig. 5).

Table 1
Oil palm biomass collected and energy potential in 2005 based on component.

Biomass component	Quantity available (million tonnes)	Calorific value (kJ/kg)	Potential energy generated (Mtoe)
Empty fruit brunches (EFB)	17.00	18838	7.65
Fiber	9.6	19068	4.37
Shell	5.92	21108	2.84
Fonds and trunks	21.1	–	–
Palm kernel	2.11	18900	0.95
Total	55.73	–	15.81

Table 2
Power and heat potential from CDM projects waste sectors.

Waste sectors (mT/yr)	Methane recovery potential (mT/yr)	Total technical power potential (MW)	Feasible total[a] installed capacity (MW)
MSW landfill	176,000	173	45
Palm Oil Processing[b] (POME)	245,000	330	160
Swine farming[c]	35,500	46	23
Other industries[d] (wastewater)	8000	35	7
Sewage	Negligible	Negligible	Negligible

[a] Total installed capacity is derived based on the power plant operation of 80% capacity factor i.e. 7008 h per year. Feasible projects based on ROE higher than 15% and attractive with CDM financing.
[b] For POME, gas engine cogen which produces power and heat is the technology based. The power efficiency of gas engine cogen is assumed at 30% where else thermal efficiency at 50%.
[c] When heat is not necessary, power generation only by gas engine is base where the power efficiency is 40%.
[d] Power/heat generation is calculated based on the heating value of methane (55.4 GJ/ton). Where, methane potential × heating value × power/thermal efficiency × MJ-kWh conversion factor (0.278).

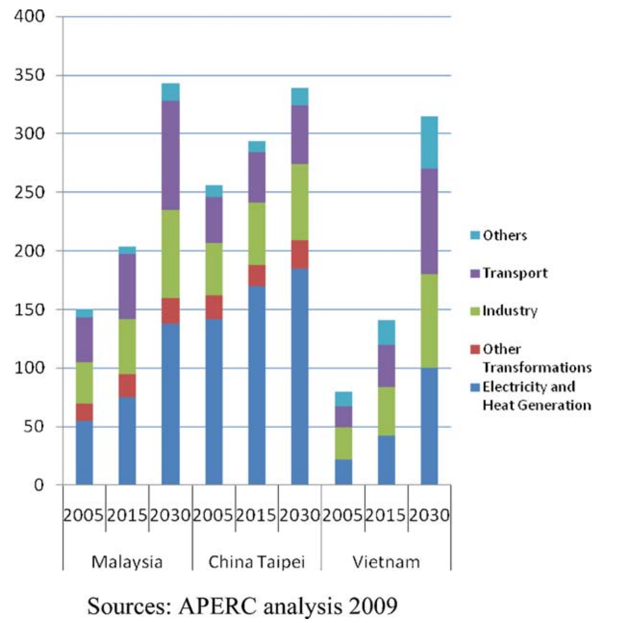

Fig. 5. Projected 3 largest contributor in CO_2 emissions for smaller economies by 2030 [23].

3. Energy demand in Malaysia

Malaysia's total energy demand in 2003 is 33.9 Mtoe. Towards year 2020, the energy demand is expected to grow at 5.4% per annum and reach 971 TWh (83.5 Mtoe) in 2020. This consumption growth is mainly driven by industrialization, with high demand in manufacturing and transportation sectors. Fig. 6 demonstrates the energy demand from 2000 to 2020 according to sector. In 2008, electricity consumption in the residential sector has recorded an increase by 4.4% compared to 2007 consumption, to a value of 19 388 GWh (1608 Ktoe) while the consumption for industrial sector is 41 689 GWh (3687 Ktoe). The final commercial energy demand in 2008 is at 44,901 Ktoe with the highest share in industrial sector of 42.6%, followed by 36.5% from transport sector, 13.8% from residential and commercial sector, and 6.4% and 0.6% from non-energy sector and agriculture sector consecutively [23].

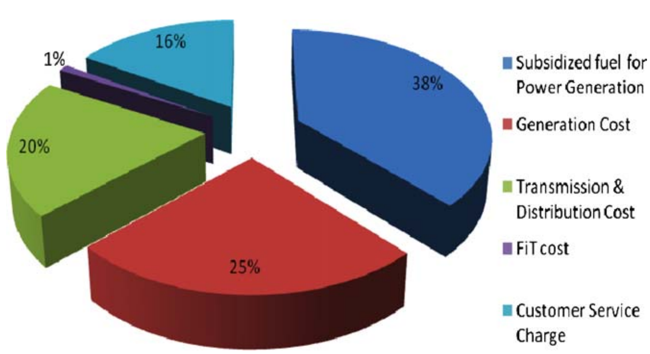

Fig. 6. Cost breakdown for average domestic electricity tariff [13].

Meanwhile, Asia-Pacific Economic Cooperation (APEC) projected the final energy demand in 2005 will increase to 6248 Mtoe in 2030, an increase of 40% with an annual rate of 1.3%. As a developing country, Malaysia tends to have a faster growth rate of 3.3% throughout 2005–2015 and slightly higher towards 2030 with 3.4% growth rate. Based on the 2009 Asia-Pacific Energy Research Centre (APERC) analysis, for 2005 and 2015, the highest energy demand is in industry sector, but towards 2030, the demand in transport sector will be the highest, since the high standard of living increases the demand in vehicle ownership. In parallel with Malaysia's rapid economic development and growing energy demand, more alternative energy sources are needed to fulfill the demand. Although Malaysia is the 3rd largest highest oil preserver in the Asia Pacific region with 4 trillion feet^2 of oil reserve in 2006, it has already realized that it cannot be totally dependent on its oil resources since, based on the 2005s production levels, it is estimated that the oil reserves is yet to last only another 15 years, while gas reserves is estimated to last for just another 29 years [24,25].

4. Malaysia's carbon emissions

One of the main reasons Malaysia is turning towards the RE solution is due to the increasing carbon emissions. During the Copenhagen Climate Change Summit, on December 2009 in Copenhagen, the Prime Minister of Malaysia conditionally agreed to commit in reducing the carbon emissions to 40% in terms of emissions intensity of gross domestic product (GDP) by the year 2020 compared to 2005 and preserve the forest land area. As an introduction, carbon emissions are associated to Greenhouse Gases (GHGs) that causes a threat to humanity. United Nations-formed scientists group named International Panel on Climate Change (IPCC), agreed that the gas mostly responsible for global warming is carbon dioxide (CO_2). Although there are different greenhouse gases that can trap more heat than carbon dioxide such as methane, nitrous oxide and chlorofluorocarbons, their concentrations are much lower than carbon dioxide. Consequently, the effect of GHG is understood as the equivalent amount of CO_2. Therefore, APERC has modeled only the emissions from carbon dioxide (CO_2) since the CO_2 emissions from fuel combustion account for over 90% of energy related greenhouse gas emissions (GHG) worldwide on CO_2 equivalent basis, and these energy related emissions in turn account for about two thirds of total greenhouse gas emissions on a CO_2 equivalent basis. Since 1990, 6 billion metric tonnes of "carbon dioxide equivalent" worldwide has been released annually, more than 20% increase. In 2006,

in the South-east Asian region, Malaysia falls in third place with 187 million tonnes of carbon emissions, behind Indonesia and Thailand [27]. And in the APEC region alone, fuel combustion is projected to grow around 40% towards 2030 from a value of 16.6 billion tones in 2005 to 23.2 billion tones in 2030 and out of this number almost half of the shares come from Electricity and Heat Generation sector. From this value, for smaller-economies country, Malaysia falls into the second largest contributor for CO_2 emissions after Taipei, Taiwan for 2005 and 2015, but is projected to lead in 2030 with slightly higher amount than Taipei as in Fig. 5 [24–27].

5. Sequence of Malaysia's actions towards Greener Energy Solutions

Although only lately Malaysia is seen to be aggressively promoting RE as a source of energy, it has already realized the need to diversify energy resources since the 1970s, during the world oil crisis, when it reveals the vulnerability of energy supply and demonstrated the world's overdependence on oil as a fuel. Thus, in that era, the development of energy-related legislation and policies were prepared to address energy requirements. As a result, the National Energy Policy was introduced in 1979 to tackle the future energy sector developments. The essence in the implementation of this policy includes guiding the future development in the supply, utilization and environmental energy sector. Among the objectives are: (1) to ensure the provision of adequate, secure, and cost-effective energy supplies through developing indigenous energy resources both non-renewable and renewable energy resources using the least cost options and diversification of supply sources both from within and outside the country, (2) to promote the efficient utilization of energy and to discourage wasteful and non-productive patterns of energy consumption, (3) to minimize the negative impacts of energy production, transportation, conversion, utilization and consumption on the environment [27–29].

Since then, from time to time, energy legislation was being reviewed. Yet, only in 1999, renewable energy was made visible through the addition of non-hydro RE resource to its four existing fuel sources for electric power generation; oil, gas, coal and hydro. This new strategy was called the Five-Fuel Diversification Strategy and it was implemented in the 8th Malaysia Plan, throughout 2001–2005. The focus of this plan is to promote sustainable development whereby under chapter 11 – Energy, it aims to provide reliable, secure, high quality and cost-effective supply of energy with efficient utilization of energy and RE as a new alternative source. It also includes incentive mechanisms to promote greater utilization of RE resources including giving 70% less statutory income, and dismissed import duty and tax of machinery and equipment. Under this plan, Malaysia has targeted to generate 5% of the country's electricity from RE source but unfortunately, by 2005, the country only achieved approximately 0.3% of its targeted RE electricity generation [30].

Subsequently, in the 9th Malaysia Plan for 2006–2010, greater utilization of renewable energy is promoted, and a more integrated planning approach was set to enhance the sustainable development of energy sector [31]. Under the Small Renewable Energy Power Programme (SREP), 2 successful projects with a combined grid connected capacity of 12 MW were implemented. One located in Puchong, Selangor with a 2 MW installed capacity fueled by biogas captured from the landfill area and another in Kunak, Sabah with generation capacity of 14 MW fuelled by oil palm residues. Both were commissioned in 2004 [32]. Moreover, a detailed plan for the development of solar, hydrogen and fuel cells was also formulated. During this plan period, the Malaysia Building Integrated Photovoltaic Technology Application Project (MBIPV) was also launched to promote a wider application of photovoltaic technology in buildings.

Recently, the Malaysian Ministry of Energy, Water and Communication (KTAK) was re-established as a result of the stern efforts in the promotion of efficient use of energy and RE as energy sources. A new function was added to the ministry, during the cabinet reshuffle, and the ministry is now known as Ministry of Energy, Green Technology and Water (KeTTHA). The new missions of KeTTHA are (1) to formulate policies and establish effective legal and regulatory framework; (2) to set the direction for the energy industry, green technology and water industry in line with national development objectives; and (3) to develop an efficient management system and effective monitoring mechanism. Based on KeTTHA's definition, Green Technology products, equipment or systems must comply to certain criteria such that (1) it minimizes the degradation of the environment, (2) it has zero or low green house gas (GHG) emission, (3) it is safe for use and promotes healthy and improved environment for all forms of life, (4) it conserves the use of energy and natural resources and (5) it promotes the use of renewable resources. This ministry also has set the 4 mainstay of its Green Technology Policies which includes issues in Energy, Environment, Economy and Social. The description of each issue is clearly stated, which are, respectively, to seek and attain energy independence and promote efficient utilization, conserve and minimize the impact on the environment, enhance the national economic development through the use of technology and improve the quality of life for all. The steps taken show the readiness of Malaysia in managing global issues on energy generation and the effect on the environment. The climax to these sequences of event, the National Green Technology Policy was launched on July 24th 2009. This policy contains 5 strategic thrusts, namely, (1) strengthen the Institutional Framework, (2) provide conducive environment for Green Technology Development, (3) intensify Human Capital Development, (4) intensify Green Technology Research and Innovations and (5) promotion and Public Awareness. This policy also includes long term goals, and it covers until the 12th Malaysia Plan (2021–2025) [29,30].

5.1. Key barrier in renewable energy in Malaysia

5.1.1. Possible key barrier in Malaysia

Malaysian government had ratified the Kyoto Protocol in September 2002, under the third mechanism, the Clean Development Mechanism (CDM). The first Malaysian project to be registered at the UNFCC as a CDM project was the Biomass Energy Plant in Lumut (capacity of 1600 MW) while the first large scale CDM was a project in Jana Manjung (capacity of 2100 MW) using biomass and coal. However, the initiative made appears to be unsuccessful, when the target of 5% contribution for 2010 from renewable energy from the energy mix is far from being achieved, with only 1.8% contribution [33,34].

In order to promote Renewable Energy generally, the Clean Development Mechanism (CDM) must have a stronger impact. To do this, significant efforts must be made to remove barriers in the dissemination of renewable energy technology. Among the most popular barrier is the fuel subsidy in which Malaysia provides enormous subsidy that result in a cheap electric price from the national grid. Besides, RET is hindered by shortage of huge investment and manpower due to lack of interest from commercial investors without any security given by any act and policy. In addition, the lack of technical know-how from the relevant agencies has led to poor-quality products and given renewable energy applications a bad reputation [35].

5.1.2. Removing key barrier

In principle, there are 2 approaches in addressing the economic performance of RET by bringing down the costs of RET and their

Table 3
Electricity demand and supply.

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Peak demand (MW)	11,055	11,833	12,504	13,848	13,809	14,375	15,172	15,540	15,943	16,332
Installed capacity (MW)	14,761	15,483	18,562	19,423	19,380	20,125	21,559	21,637	24,015	24,187
Reserve margin (%)	33.5	30.8	48.4	40.3	40.3	40.0	42.1	39.2	50.6	48.1

Sources: Economic Planning Unit, Ministry of Energy, Green Technology and Water, Tenaga Nasional Berhad, Sabah Electricity Sdn. Bhd. and Sarawak Electricity Corporation Berhad.

related energy services and abolishing market distortions against RET such as direct subsidies of fossil fuel or lacking internalization of external costs. In evidence, the first approach can be done by implementing policies that can successfully encourage technological development and cost savings by creating enabling frameworks. The second approach, is described as 'leveling the playing field' so that RET and conventional energy technologies can compete at the same level [35] (Table 3).

Benjamin K. Sovacool through his interviews of participants from consumers and consumer advocates, members from electric utilities, independent power provider and regulatory agencies at state and federal level from 93 institutions of 13 countries over a 3 year period, found that the four most favorable policy mechanism are: eliminating subsidies, pricing electricity accurately, creating a national feed-in tariff, and implementing a national systems benefit fund as in Table 4. He suggested for mature energy technologies, the subsidies are best eliminated by immediately repealing it. However, the Federal Ministry of Environment, Nature Conservation and Nuclear Safety suggest that by implementing gradual reductions in subsidies over a period of time it will avoid social unrest besides helping the population to accept it better in a transparent manner by highlighting its long term necessity and advantages. The advantages of subsidy policies redesign is to ensure the dissemination of RET and help ease the burden on public budgets due to the upkeep of rising prices of fossil fuels because of the shortage and growing world demand. In addition, it is essential to strengthen the role of independent power producers (IPPs), by giving priority to the interests of renewable-energy based IPPs due to the decentralized nature of RE that needs a higher number of operators' implementation which has been a key driver in the growth of Germany's electricity sector and China's RE law. Besides removing the barriers that negatively impact RET, it is also essential to introduce supportive policies that can positively push them into the market. Other supportive measures include establishing quality manufacturing standards for renewable energy equipment, establishing dedicated loan facilities with low interest rates to finance for RET, lowering taxes and customs duties on RET equipment, giving practical support to those who implement renewable energy technology and significantly raising public awareness of renewable energy through campaigns on all media, and building technical capacity. These supportive measures can help the intersection of the cost of RET with conventional energy by 2030, taking into account the external cost of conventional energy technologies, falling RET prices and the rising prices of fuel [35–37] (Table 5).

5.1.3. Current situation in Malaysian RE scenario

Malaysian Government has taken continuous effort in the development of RE through various support and promotion programmes such as Malaysian Industrial Energy Efficiency Improvement Project (MIEEIP), Small Renewable Energy Power Programme (SREPP), Building Energy Efficiency Programme (BEEP), Green Building Index (GBI) and Malaysia Building Integrated Photovoltaic Technology Application (MBIPV) and Biomass Grid-Connected Power Generation and Co-Generation (Biogen) [38]. These efforts have provided a good platform for the growth of renewable energies in Malaysia. By 31st December 2009, the RE of grid capacity already reached 440 MW while RE capacity connected to power utility grid is 55.5 MW. Recently, the Malaysian cabinet approved the RE act and Act for FiT Implementing Agency on 2nd April 2010, followed by the formal announcement of the National RS Policy and Action Plan under the 10th Malaysia Plan on 10th June 2010 [39]. The plan was to implement FiT based on the 'polluters pay concept' where consumers with high electricity bills will have to pay more for their carbon emissions. The so-called 'Renewed' Renewable Energy Initiative will be implemented in the 10th Malaysia Plan (2011–2015) and beyond where the policy statement of the National RE Policy is enhancing the utilization of indigenous renewable energy resources to contribute towards national electricity supply security and sustainable socio-economic development. The objectives are (1) to increase RE contribution in the national power generation mix, (2) to facilitate the growth of the RE industry; (3) to ensure reasonable RE generation costs, (4) to conserve the environment for future generation; and (5) to enhance awareness on the role and importance of RE [14,39].

The goal is to increase electricity supply from RE to 5.5% of the energy mix by 2015. The expected annual share on RE capacity annually is shown in Table 6. Soon, the Renewable Energy Act and the Act for a Feed-in Tariff will be debated in October 2010, and if approved, the program will be launched at earliest by second quarter of 2011 and will be managed by the Sustainable Energy Development Authority (SEDA). The source of funds for FiT is shown as in Fig. 6 and the proposed Fit rates are as shown in Table 7. For every RM100 per month paid, RM1 will go to the funding of FiT and

Table 4
Four most preferred energy efficiency and renewable power policy mechanism.

Impediment	Policy	Details
Political support for RE has been inconsistent and unfair	Eliminate subsidies	Immediately repeal federal government subsidies for mature energy technologies
Consumers do not receive accurate price signals for electricity	Create accurate electricity prices	Abolish electricity rate caps, eliminate declining block rate pricing, reflect time of use in electricity rates, and internalize external costs
Utilities and businesses generally will not invest in renewable power	Make renewable energy mandatory	Create a national feed-in tariff (FIT) and guarantee renewable power generators access the grid
The public is uninformed about energy efficiency and renewable energy	Inform the public and protect the poor	Establish a national systems benefit charge (SBC) to generate revenue to distribute information and educate the public, provide low-income assistance and weatherization, and fund energy efficiency and demand site management (DSM) programmes

Table 5
Critical factor for guaranteed effective FiT in Malaysia.

Factor	Description
Access to grid is guaranteed	Utilities legally obliged to access all electricity generated by RE private producers
Local approval procedures are streamlined and clear	–
FiT rates must be high enough	To produce a ROI plus reasonable profit to act as an incentive
FiT rates must be fixed for a period (typically 20 years)	To give certainty and provide businesses with clear investment environments
Adequate degression for FiT rates	To promote cost reduction to achieve grid parity
Adequate fund created	To pay for FiT incremental cost rates and guaranteed the payment for the whole FiT contract period
Implemented by a competent agency	Includes monitoring, progress reporting and transparency

Table 6
Projected annual shares on RE capacity after FiT implementation.

Year	Biomass	Biogas	Mini-hydro	Solar PV	Solid waste	Total per annum (MW)
2011	110	20	60	9	20	219
2012	40	15	50	11	30	146
2013	50	15	60	13	40	178
2014	60	25	60	15	50	210
2015	70	25	60	17	60	232
2016	80	25	60	19	40	224
2017	90	30	50	21	40	231
2018	100	30	40	24	30	224
2019	100	30	30	28	30	218
2020	100	25	20	33	20	198
:				:	:	:
2030				280	2	282
:				:	:	:
2040				850	2	852
:				:	:	:
2050				1350	2	1352

Table 7
Proposed Malaysian FiT rates (starting 2011).

RE technologies/resources	FiT duration	Range of FiT rates[a] (RM/kWh) Min–Max	Annual degression[a]	Displaced electricity cost[b] (RM/kWh)
Biomass (palm oil, agro-based)	16 years	0.24–0.35	0.5%	0.2214
Biogas (palm oil, agro-based, farming)	16 years	0.28–0.35	0.5%	0.2214
Mini-hydro	21 years	0.23–0.24	0%	0.2214
Solar PV	21 years	1.25–1.75	8%	0.3504
Solid waste and sewage	21 years	0.30–0.46	1.8%	0.2214
Wind	21 years	0.23–0.35	1.5%	0.2214
Ocean, geothermal	21 years	0.28–0.46	1%	0.2214

[a] Subject to final confirmation upon RE Law enactment.
[b] Subject to tariff increment.

the 1% from FiT cost will not affect the low income consumers with usage <200 kWh/month. This step is believed to encourage energy efficiency (EE) and DSM [14,40].

6. Conclusion

An overview of the current perspective of the Renewable Energy Development in Malaysia has been presented in detail in this paper. The study examined the plentiful resources of RE, the current capacity and also its projected potential for electricity generation in the future. The grand vision of being a developed country by 2020 has pushed Malaysia towards promoting RE thus solving its crude oil scarcity and limiting its carbon emissions. Therefore, through a comprehensive policy, and a dedicated political and social support in implementing them, Malaysia could be one of the largest producers in renewable and sustainable energy in the world.

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